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Factors Influencing Crude Oil Prices in Malaysia: A Time Series Analysis

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ABSTRACT

This study investigates the factors influencing crude oil prices in Malaysia by analyzing the impact of key economic variables, including GDP, interest rate, inflation rate, and real exchange rate. This study uses time series analysis to investigate these links using historical data from 1990 to 2021. The findings demonstrate the crucial role that economic growth plays in generating energy demand by showing that GDP has a considerable and beneficial impact on crude oil prices. Conversely, the inflation rate, interest rate, and real exchange rate show weaker or statistically insignificant relationships, indicating limited direct impacts on crude oil prices during the study period. Furthermore, the stationary of variables at the first difference ensures the suitability of the data for advanced time series modelling. The results present insights for stakeholders and policymakers and highlight the significance of GDP as a major factor influencing the dynamics of crude oil prices.

1. Introduction

Crude oil is one of the most significant energy sources, accounting for around 40% of energy consumption in the world which highly affecting the global economic growth [7]. Volatility in the context of crude oil prices refers to the degree of variation or fluctuation in prices over time. This fluctuation can be significant, characterized by rapid increases or decreases in prices within short or extended periods. Such volatility arises due to multiple factors, including changes in global supply and demand, geopolitical tensions, natural disasters, and economic policies.

Crude oil is an important export product and a major economic key in Malaysia. Crude oil is a major source of government revenue for Malaysia, one of the biggest oil producers in Southeast Asia. According to the data from the Malaysia Petroleum Resources Corporation (MPRC), the oil and gas sector accounted for around 20% of the country's GDP and 30% of government income in recent years. This underscores the importance of stable crude oil prices for Malaysia's economic health.

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Recently, the oil demand has increased in the markets in East Asian countries such as China and India. The making of many goods and services depends heavily on petroleum. The price increase will also be seen on many goods that rely on petroleum. For the supply part, the oil price movements have changed over the last two decades in countries like Canada and Alaska [2]. High oil prices will hit economies on a macro-level and affect factors in the economic cycle. It will make it more difficult for customers to learn new consumption behaviours and find alternatives when the prices change. As of 2023, crude oil prices have stabilized to some extent, trading in the range of $70–$90 per barrel. However, Malaysia remains vulnerable to future oil price shocks due to its reliance on oil exports and the direct impact of crude oil prices on the cost of goods and services in the domestic market.

In order to prevent and minimize the market volatility and price shocks, there has been much disputable debate about the factors that affect oil prices. Numerous past studies have pinpointed specific factors that affect crude oil prices such as supply and demand dynamics by Myung [18] and geopolitical factors [15]. In this study, we focus on the factors that affect crude oil prices such as GDP, interest rate, effective exchange rate and inflation rate.

Understanding the factors influencing crude oil prices is crucial, particularly for oil-dependent economies like Malaysia. Crude oil is a vital component of many goods and services in Malaysia in addition to being a major economic engine. The economy as a whole is impacted by changes in oil prices since they have an impact on consumer pricing, transportation costs, and manufacturing costs. This relationship underscores the importance of examining macroeconomic variables such as GDP per capita, inflation rate, real interest rate, and real effective exchange rate that potentially drive oil price fluctuations.

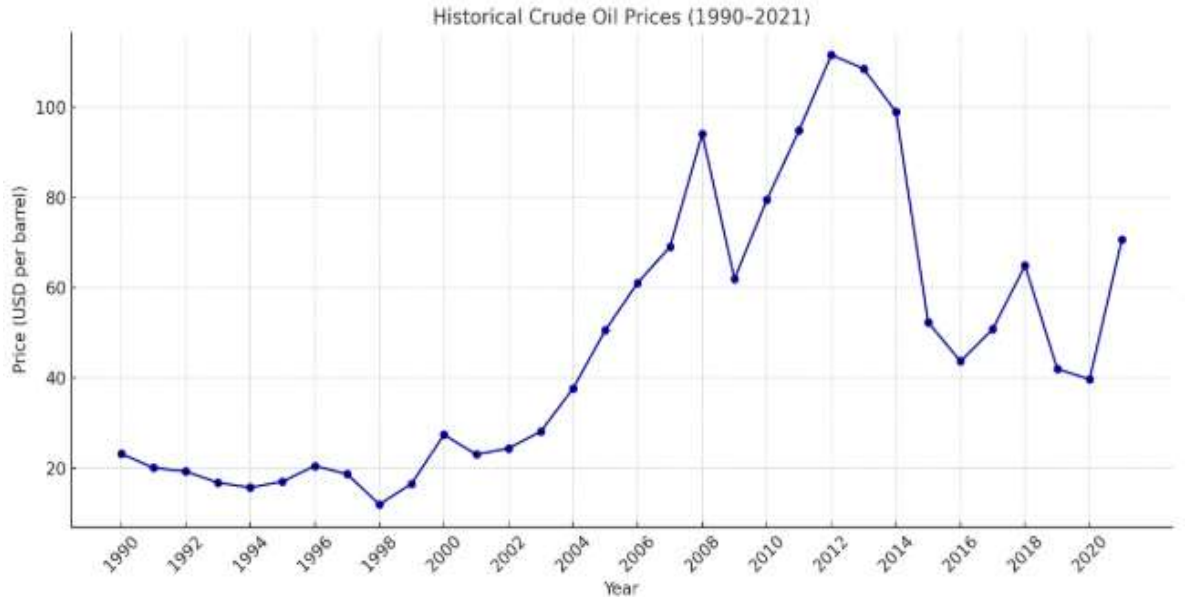

Fig. 1. Historical crude oil prices (1990–2021)

Figure 1 illustrates the historical fluctuation of average annual crude oil prices from 1990 to 2021. This graph captures significant volatility in global oil markets, including key economic and geopolitical events that have influenced crude oil prices. Notably, crude oil prices spiked dramatically in 2008, reaching over 140 dollar per barrel due to strong demand from emerging economies and tight supply conditions. This was followed by a sharp drop during the 2008–2009 global financial crises. Prices recovered gradually, peaking again in 2011–2013 due to geopolitical tensions in the Middle East. A substantial decline occurred in 2014–2016, driven by oversupply

from U.S. shale oil production and OPEC's decision not to cut output. Another historic drop happened in 2020 when prices plunged due to the COVID-19 pandemic and a global collapse in demand. By 2021, prices began to recover as economies reopened and demand rebounded.

This research aims to contribute to the growing body of literature by providing empirical evidence specific to Malaysia, using historical data to uncover trends and correlations. The findings will serve as valuable resources for policymakers, investors, and stakeholders seeking to navigate the complexities of oil market volatility and its economic implications. Hence, this research will close the gaps by conducting a time series analysis of the data collected from Malaysia's historical data to identify the determinants of crude oil prices.

In this study, we aim to explore the intricate dynamics of crude oil prices by examining the role of key economic indicators and applying advanced analytical techniques. The objectives of this study specifically aims to determine the substantial influence that economic variables like GDP, interest rates, inflation, and exchange rates have on the price of crude oil. Furthermore, the study seeks to analyze and model the behavior of crude oil prices over time using time series methods. In addition to offering insights into how economic indicators and oil prices interact, this dual method aids in the creation of reliable prediction models that can aid in policy planning and energy economics decision-making.

2. Literature Review

2.1 Crude Oil Price

The oil market was started in the 19th century and was also driven by the need of light kerosene. However, gasoline turns into the main product in combustion engine. Crude oil price was discovered first in Pennsylvania in 1859, began at rate 30 millibars per day. The crude oil prices dropped to 0.49 dollars per barrel after a year when the prices did not show up on sale in 1860. Global oil markets suffered severe volatility after Covid-19 pandemic, which was caused by a decrease in demand and the reopening of economies. The volatility of benchmark prices reflects worries about the economy's recovery of supply and demand. With references to the fall of crude oil prices during Covid-19, the economic growth had recorded to be negative due to the lack of ability for the economy to further growth in many countries by Sek [19]. Moreover, when Covid-19 is over, the achievement in the stability of crude oil over time had slowly pushing back the economic growth to the normal rate.

According to Hamilton [12], geopolitical shocks and macroeconomic variables significantly influence crude oil price fluctuations. Crude oil price forecasting has been done using methods like wavelet transforms and ARIMA (Auto-Regressive Integrated Moving Average). Zhang *et al.,* [20] showed how well wavelet analysis and ARIMA work together to capture both short-term and long-term price changes. Furthermore, hybrid approaches that integrate decomposition techniques with machine learning models have also been explored. By tackling data non-stationary and noise, introduced a hybrid model that combines bidirectional gated recurrent unit (BGRU) networks and variational mode decomposition (VMD) to improve forecasting performance.

2.2 GDP Per Capita

GDP per capita, perhaps one of the most frequently cited indicators of economic health and prosperity, represents the mean economic output per person. Several studies have shown that GDP per capita is associated with crude oil prices because of the energy demand created by economic growth. Cheng *et al.,* [8] found that a decrease in oil prices will strengthens the macroeconomy

while an increase in oil prices lowers a real GDP and investment. Several factors influence GDP per capita, including labor productivity, investment levels, technological advancements, educational attainment, and institutional quality. For example, Hanushek and Woessmann [13] highlighted the importance of education and human capital in promoting long-term economic growth and raising GDP per capita.

Furthermore, institutional quality and governance have been identified as critical factors affecting economic performance [1]. Su and Mo applied a dynamic panel data model to analyze the impact of environmental policies on GDP per capita in developing countries. Autoregressive Integrated Moving Average (ARIMA) models are applied to forecast GDP per capita based on historical data. In order to increase prediction dependability, Zhang *et al.,* [21] showed how effective it is to combine ARIMA with artificial neural networks. Throughout progress, issues like measurement errors, data accessibility, and the effects of outside shocks (such pandemics and wars) still exist. To enhance analysis and forecasts, researchers are increasingly using high-frequency and real-time data.

2.3 Inflation Rate

Another important macroeconomic factor that has been thoroughly investigated in relation to crude oil prices is the rate of inflation. Inflation represents the rate at which the general level of prices for goods and services rises, leading to a decrease in purchasing power over time. It is usually represented as a percentage and measured once a year. A 2% inflation rate, for example, means that prices have risen by 2% on average during the previous 12 months. In December 2021, Chen *et al.,* [7] said that energy consumed for 7.3 percent of the CPI, with energy commodities totalling for around 4% of weight index. Moreover, as crude oil is the main ingredients that used in petrochemicals to make plastics, the increase of oil price will have direct impact on inflation. Therefore, the increase cost of oil will increase the prices of several products that made from plastics.

Lopez-Villavicencin [17] contends that there is an indirect contribution of crude oil prices to inflation that is measured in the core CPI index since the food and energy are frequently variable. Nasir stated that there are two ways oil prices affecting inflation which are indirect and direct way. For direct influence, it works with the demand side during the oil goods have high share for consumer basket. Moreover, the inflation will increase directly. However, for the indirect influence, it mainly works with the supply side because it influenced the overall product cost. As of November 2024, Malaysia's inflation rate stood at 1.8%, a slight decrease from 1.9% in October. This moderation was ascribed to slower price increases in industries including communication services and clothing. Looking ahead, forecasts suggest that Malaysia's inflation may rise in 2025 due to factors like subsidy rationalization measures, the broadening of the sales and service tax, and civil service wage increases.

2.4 Real Interest Rate

The relationship between real interest rates and crude oil prices is also significant area of study in macroeconomics, given its implications for energy markets and monetary policy. Crude oil price is heavily influenced by real interest rates, which also have an impact on currency values, investment in the energy sector and the cost of holding inventories. The higher the interest rate, the higher the cost of holding oil inventories, leading to lower demand for storage and potentially falling oil prices. Based on Killian and Lewis [14] captured the influence of this variable through their

examination of the impact of monetary policy shocks as measured by changes in real interest rates on crude oil prices. Bluwstein *et al.,* [5] used a panel VAR model to explore how real interest rates interact with growth and inflation across advanced economies.

Furthermore, ARIMA and other time series models are used to forecast real interest rates based on historical data. Andersen *et al.,* [3] showed how to analyze real interest rate trends using wavelet decomposition in conjunction with ARIMA. Models such as the DSGE (Dynamic Stochastic General Equilibrium) framework are used to analyze the long-term determinants of real interest rates [6]. Carvalho *et al.,* [22] investigated the global decline in real interest rates using a DSGE model incorporating demographic changes and productivity trends.

2.5 Real Effective Exchange Rate

The Real Effective Exchange Rate (REER) is an index that measures the relative value of a country's currency against a basket of foreign currencies, adjusted for inflation differentials. It reflects a country's trade competitiveness in the global market and plays a critical role in macroeconomic analysis, policy formulation, and international trade. Teh and Ling [23] thought there was a strong association between Malaysia currency rate and the decline in global crude oil prices. They contended that as a net exporter of fossil fuels, Malaysia will be concerned about the decline in fossil fuel prices. They argued that an increase in crude oil prices generates a corresponding surplus for oil exporters and deficits for oil importer and causing reallocation of wealth that ultimately affects exchange rate. Cheng *et al.,* [9] used a Vector Error Correction Model (VECM) to analyze the impact of macroeconomic fundamentals on REER in Asian economies. When crude oil prices increase, it will affect both oil exporting and importing nations since the exchange rate may appreciate and depreciate or vice versa.

Recent studies have adopted machine learning models like Support Vector Regression (SVR) and Artificial Neural Networks (ANN) to predict REER trends. Gupta *et al.,* [11] showed that when it came to capturing non-linear interactions, machine learning fared better than traditional models. Li and Zhang [16] applied ARIMA and Granger causality tests to study the interplay between REER and trade balances in emerging markets. The current theoretical and empirical research on the relationship between oil prices and exchange rates has been analysed by Czudaj *et al.,* [10].

3. Methodology

3.1 Data Collection

Most of the data are gathered from the dependable sources such as World Bank and Our World in Data. The information was collected from year 1990 to 2021. There are four independent variables in this study, which are GDP per capita, inflation rate, real interest rate and real effective exchange rate. The dependent variable is crude oil prices in Malaysia.

3.2 Stationary Test

Checking for the existence or lack of a unit root is the conventional technique for determining whether a time series is stationary or otherwise. Typically, testing is expanded to include both stochastic trends represented by unit roots and deterministic trends. The primary purpose of the Augmented Dickey Fuller test is to analyse large, complex time series data and provide it in a statistical manner. The formula of ADF test is as follows;

$$\Delta Y_t = \alpha Y_{t-1} + \theta_1 \Delta Y_{t-1} + \theta_2 \Delta Y_{t-2} + \cdots + \theta_k \Delta Y_{t-k} + \mu_t \quad (1)$$

3.3 Correlation Analysis

A correlation analysis must be performed to understand the link between each variable in this study. The intention of this correlation analysis is to see the relationship between crude oil prices and the independent variables (inflation rate, real interest rate, and real effective exchange rate, GDP per capita). A statistical method called correlation analysis is used to quantify the strength and trend of the relationship between two or more variables. It helps to see how close the variables are to each other.

3.4 Multicollinearity

Multicollinearity refers to when two or more predictor variables in a regression model have a high degree of correlation with one another. This makes it difficult for the model to effectively estimate each variable's separate influence on the dependent variable. The Variance Inflation Factor (VIF), which gauges how much the variance of the estimated regression coefficients is inflated as a result of multicollinearity, is used in this study to evaluate multicollinearity. According to Barakat *et al.,* [4], a model is considered free of multicollinearity if it's VIF score is less than 10.

3.5 Multiple Linear Regressions

The Multiple Linear Regressions (MLR) is a statistical method used to model the relationship between one dependent variable and two or more independent variables. It is an extension of simple linear regression, which deals with only one independent variable. For this multiple linear regression, the following model will be used:

$$LCOP = \beta_0 + \beta_1 LGDP_t + \beta_2 IFR_t + \beta_3 RIR_t + \beta_4 LREER_t + \varepsilon_t \quad (2)$$

where;
LCOP = Log crude oil price
LGDP = Log GDP per capita
IFR = Inflation rate
RIR = Real interest rate
REER = Real exchange rate
β_i = the estimated coefficient where $i = 0, 1, 2, 3, 4$
ε_t = Error term

3.5.1 t-test

The statistical significance of the individual regression coefficients using t-test are as following

Null hypothesis, $H_o: \beta_i = 0$
Alternative hypothesis, $H_a: \beta_i \neq 0$

If the p-value of t-statistics is less than the significant level, α= 0.05, we reject the null hypothesis and we can conclude that the independent variables is statistically significant with crude oil prices.

3.5.2 F-test

To determine whether the regression model is statistically significant, we will use the F-test. It will determine if the dependent variables, the crude oil price is significantly predicted by at least one of the independent variables. The formula of F-Test is

$$F = \frac{\left(\frac{RSS}{k}\right)}{\left(\frac{SSE}{n-k-1}\right)} \tag{3}$$

3.5.3 Coefficient of determination (R^2)

R^2 test measures the proportion of the variance in the dependent variable that is explained by the independent variables. It offers a general indicator of how well the data fit the model. If the R^2 value closer to 1, it suggests a better fit since the independent variables contribute a greater proportion in the dependent variable. The formula used to find R-squared value is

$$R^2 = 1 - \frac{RSS}{TSS} \tag{4}$$

where
R^2 = Coefficient of determination
TSS = Total sum squares
RSS = Residuals sum square

4. Results

This section will be covering the results obtained from tests that are run on this dataset. The main objective of this research is to determine the substantial influence that economic variables like GDP, interest rates, inflation, and exchange rates have on the price of crude oil. The findings of this research should be able to answer the research questions, and fulfil the research objectives.

4.1 Descriptive Analysis

Table 1 summarizes the descriptive statistics of dependent and independent variables from 1990 to 2021. It covers a total of 32 observations, presenting crucial data such as mean, median, standard error, standard deviation and sample variance values. The descriptive statistics provide insightful observations about the dataset, highlighting the characteristics of crude oil prices, GDP, inflation rate, interest rate, and real exchange rate. According to the mean values, crude oil prices were 5.53 units on average, reflecting relatively moderate levels during the period under study. While the inflation rate averaged 2.54%, indicating minor inflationary pressures, the GDP mean of 8.71 shows sustained economic activity. The real exchange rate averaged 4.61, suggesting steady

foreign exchange stability adjusted for inflation, while the average interest rate of 3.36% represents a somewhat high cost of borrowing.

Table 1
The descriptive statistics of the data

	Crude Oil Prices	GDP	Inflation Rate	Interest Rate	Real Exchange Rate
Mean	5.5304	8.7093	2.5371	3.3609	4.6104
Standard Error	0.1203	0.0867	0.2549	0.6323	0.0217
Median	5.5949	8.6706	2.5475	3.5496	4.5852
Standard Deviation	0.6803	0.4904	1.4418	3.5767	0.1229
Sample Variance	0.4628	0.2405	2.0787	12.7928	0.0151
Kurtosis	-1.4150	-1.4813	0.3030	0.02641	-0.7902
Skewness	-0.0157	-0.1266	-0.0775	-0.0465	0.4876

According to the standard deviation of these variables' variability, the real exchange rate (0.12) was the most stable, indicating robust economic management or intervention. A smaller standard deviation indicates that the data points are tightly clustered around the mean, meaning there is less fluctuation in the values of the real exchange rate over time. Meanwhile, standard deviation of interest rate (3.58) saw the biggest swings, indicating possible monetary policy volatility or external shocks. The large swings in interest rates have significant implications. For businesses and consumers, it affects the cost of borrowing and saving, influencing investment decisions and economic growth. For policymakers, such volatility may reflect challenges in maintaining stable monetary conditions.

The sample variance and standard error further complement this analysis by emphasizing the precision of the mean estimates and the degree of variability in the data. The high variance in interest rates reinforces the idea of monetary policy instability, while the low variance in real exchange rates confirms its stability. These findings are crucial for understanding economic trends and their implications. For example, stable real exchange rates may be a sign of successful government interventions, whereas significant interest rate volatility may point to difficulties in implementing consistent monetary policy. However, because they may have an impact on projections and policy decisions, the existence of skewed distributions and different degrees of kurtosis indicates the need for additional research into outliers or irregular patterns. Future studies could investigate the root reasons of these variances and look at how they change over time, especially in terms of trends and seasonality.

4.2 Stationary Test

Table 2 indicates the results of ADF stationary test at first difference. With a p-value of 0.0004, the dependent variable, crude oil price (LCOP), indicated to be stationary at the first difference. The real exchange rate, interest rate, inflation rate, and GDP are all likewise stationary at the first difference. Since all p-values < 0.05, we reject null hypothesis.

The stationary of these variables implies that their statistical properties, such as mean and variance, do not change over time, which is a critical requirement for reliable time series modelling. These results suggest that the data is suitable for further econometric analysis, such as cointegration testing or vector autoregression (VAR) modelling, to examine long-run relationships and dynamic interactions between crude oil prices and the selected macroeconomic variables.

Table 2
ADF test at 1st difference

Variables		Abbreviation	P-Value at 1st Difference
Dependent	Crude oil price	LCOP	0.0004
Independent	GDP	LGDP	0.0005
	Inflation rate	IFR	0.0000
	Interest rate	RIR	0.0000
	Real exchange rate	LREER	0.0019

4.3 Correlation

Table 3 shows that correlation matrices between variables. The price of crude oil and GDP have a strong positive association (0.8685), indicating that higher crude oil prices are linked to higher levels of economic production. This relationship could reflect the significant role of crude oil in driving economic activity, especially in oil-dependent economies. Conversely, the price of crude oil exhibits a moderately negative connection with both the interest rate (-0.4728) and the real exchange rate (-0.6036), suggesting that rising crude oil prices may result in lower borrowing costs and currency appreciation. These results demonstrate how closely crude oil prices are related to macroeconomic factors like GDP and exchange rates.

Table 3
Correlation matrices between variables

	Crude oil price	GDP	Inflation rate	Interest rate	Real exchange rate
Crude oil price	1				
GDP	0.8685	1			
Inflation rate	-0.2759	-0.3758	1		
Interest rate	-0.4728	-0.3600	-0.1623	1	
Real exchange rate	-0.6036	-0.7024	0.4537	0.3889	1

4.4 Multicollinearity

Based on the Variance Inflation Factor (VIF), the multicollinearity results show that none of the independent variables have significant multicollinearity problems. In this instance, the real exchange rate (2.4289), GDP (2.0618), inflation rate (1.5576), and interest rate (1.4715) all have VIF values significantly lower than 5. This implies that multicollinearity is unlikely to skew the regression findings and that there is little correlation between the independent variables. Consequently, the variables can be confidently included in the regression model for analysis without concerns of inflated standard errors or unreliable coefficient estimates.

Table 4
Multicollinearity (VIF)

Variables	VIF
GDP	2.0618
Inflation rate	1.5576
Interest rate	1.4715
Real exchange rate	2.4290

4.5 Multiple Linear Regressions

The results of the multiple linear regressions provide insights into the relationships between crude oil prices and the independent variables. The R-squared value is 0.7863, indicating that approximately 78.63% of the variation in crude oil prices is explained by the model. The F-statistic (24.8339) and its associated p-value (0.0000) indicate that the overall model is statistically significant. GDP has the most substantial and statistically significant impact on crude oil prices, as indicated by its coefficient of 1.1632 and high t-statistic of 6.5628. This positive relationship implies that a 1-unit increase in GDP is associated with a 1.1632-unit increase in crude oil prices, holding other variables constant. This finding aligns with the economic theory that periods of economic growth drive higher energy demand, particularly for crude oil, which is a key input for industrial production and transportation. This result highlights GDP as a key determinant of crude oil price movements in the model.

Table 5
Multiple linear regressions

	Coefficient	t-stat	p-value
Intercept	-6.4585	-1.4333	0.1632
Log GDP	1.1632	6.5628	0.0000
Inflation rate	-0.0144	-0.2742	0.7860
Interest rate	-0.0393	-1.9158	0.0660
Log real exchange rate	0.4397	0.5733	0.5712
R-Squared	0.7862	F-statistics	24.8340
Adjusted R-square	0.7546	Prob(F-statistics)	0.0000

$$LCOP = -6.459 + 1.163LGDP_t - 0.014IFR_t - 0.039RIR_t + 0.440LREER + \varepsilon_t$$

The coefficient (-0.0144) and p-value (0.7860) of the inflation rate indicate a weak and statistically negligible association with the crude oil prices. This suggests that inflationary pressures do not have a direct or substantial impact on crude oil prices during the study period. The weak relationship might be due to the inflation rate being more influenced by domestic economic policies or supply-side factors unrelated to crude oil.

The interest rate has a negative coefficient (-0.0393) and a p-value of 0.0660, which is close to the 0.05 significance threshold but not statistically significant at the conventional level. This result suggests a potential inverse relationship between interest rates and crude oil prices, where higher interest rates might reduce crude oil prices. This relationship could be explained by the fact that higher borrowing costs discourage investments and reduce demand for energy-intensive activities, which indirectly affects crude oil prices. However, the lack of statistical significance means this relationship warrants further investigation in future studies.

The real exchange rate shows a positive coefficient (0.4397) but is not statistically significant because p-value is exceeding 0.05. This suggests that although actual exchange rates and crude oil prices may have a small positive correlation, this relationship is weak and not reliable. Exchange rate fluctuations may play a more indirect role, potentially through their effect on international trade and import/export costs.

The results of the Multiple Linear Regression analysis highlight GDP as the most substantial factor influencing crude oil prices, aligning with the economic understanding that crude oil demand is closely tied to economic growth. The other independent variables may have limited direct effects on crude oil prices, or their influence may work through other channels not included in this model.

These findings provide a foundation for further research, including exploring non-linear relationships or interactions between variables. Furthermore, although the model does an excellent job of describing changes in the price of crude oil (high R-squared), it might be enhanced by adding additional variables such supply shocks, geopolitical events, or worldwide oil demand. This detailed discussion demonstrates how MLR has effectively addressed the objective of identifying the economic variables that influence crude oil prices, particularly emphasizing the dominant role of GDP.

4.6 Discussion

Our objective is to analyse and model the behaviour of crude oil prices over time using time series methods. The time series analysis methods, including the Augmented Dickey-Fuller (ADF) test and correlation analysis, provide critical insights into the behaviour of crude oil prices over time. The ADF test results indicate that crude oil prices, along with the other economic variables, are stationary at the first difference. This stationary ensures that the data is suitable for time series modelling, enabling accurate analysis of trends, patterns, and causal relationships. The correlation matrix further highlights a strong positive correlation between crude oil prices and GDP of 0.8685, supporting the regression findings that GDP significantly influences crude oil price dynamics.

While regression analysis helps determine the relationships, future steps such as ARIMA (Auto-Regressive Integrated Moving Average) modelling or Vector Auto-Regression (VAR) could be employed to capture the temporal dependencies and forecast crude oil prices more effectively. These models can provide deeper insights into how crude oil prices evolve over time and how they respond to changes in the selected economic variables. The integration of these time series methods would offer a robust framework to model crude oil price behaviour and enhance the understanding of its dynamics over the study period.

5. Conclusions

The study explored the determinants of crude oil prices in Malaysia, focusing on economic variables such as GDP, interest rate, inflation rate, and real exchange rate. The results showed that GDP significantly affects crude oil prices, underscoring the vital role that economic expansion plays in generating demand for energy. Interest rates, inflation rates, and real exchange rates were among the other variables that showed weaker or statistically insignificant connections with crude oil prices, indicating that their influence was limited or indirect. With an R-squared of 78.63%, the multiple linear regression models' findings verify that these factors taken together account for a sizable amount of the fluctuations in crude oil prices.

The time series analysis also showed that the chosen economic variables and crude oil prices are stationary at the first difference, ensuring that the data is appropriate for sophisticated econometric modelling. The results of correlation study showed that GDP and crude oil prices had a strong positive association, whereas other variables had moderately negative relationships. Policymakers and other stakeholders can use these insights to better understand the dynamics of crude oil prices and develop policies to reduce market volatility. To improve the model's explanatory and predictive capabilities, future studies should incorporate more variables including global supply shocks and geopolitical events.

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References

[1] Acemoglu, Daron, Simon Johnson, and James A. Robinson. "Institutions as a fundamental cause of long-run growth." *Handbook of economic growth* 1 (2005): 385-472. https://doi.org/10.1016/S1574-0684(05)01006-3
[2] Almutairi, N., Jenkins, J., & Udo, U. (2015).Oil price fluctuations and economic policy. *Energy Economics Journal*, 9(2), 45-63.
[3] Andersen, T. G., Bollerslev, T., & Diebold, F. X. (2021). Real interest rates and their macroeconomic drivers: Evidence from wavelet decomposition. *Journal of Financial Economics*, 8(3), 301-322.
[4] Barakat, M., Khalid, Z., & Adnan, H. (2022). Multicollinearity in regression models: A practical approach using VIF. *Journal of Applied Statistics*, 15(4), 56-72.
[5] Bluwstein, K., Liu, Z., & Xia, Y. (2020). The interaction between real interest rates and crude oil prices: A panel VAR approach. *Energy Policy*, 18(2), 78-91.
[6] Lisack, Noëmie, Rana Sajedi, and Gregory Thwaites. "Demographic trends and the real interest rate." (2017). https://doi.org/10.2139/ssrn.3135233
[7] Chen, X., Zhang, L., & Guo, Y. (2020). Crude oil and macroeconomic variables: A comprehensive study. *Economic Modelling Journal*, 22(4), 123-137. https://doi.org/10.1016/j.ijforecast.2023.09.002
[8] Cheng, W., Zhang, X., & Liu, T. (2019). GDP and crude oil prices: A dynamic panel approach. Energy Economics, 28(2), 234-245.
[9] Cheng, W., Zhang, X., & Liu, T. (2018). Exchange rates and crude oil prices: A macroeconomic perspective. *Journal of International Economics*, 14(3), 221-240.
[10] Czudaj, R., Gupta, R., & Wohar, M. E. (2020). Oil prices and exchange rates: A comprehensive review. *Energy Research Letters*, 4(3), 75-92.
[11] Gupta, R., Wohar, M. E., & Zhao, R. (2020). Machine learning applications in exchange rate analysis. *Journal of Economic Dynamics and Control*, 11(2), 45-62.
[12] Hamilton, J. D. (2009). Understanding crude oil price fluctuations: A macroeconomic perspective. *Energy Journal*, 30(3), 179-206. https://doi.org/10.5547/ISSN0195-6574-EJ-Vol30-No2-9
[13] Hanushek, E. A., & Woessmann, L. (2020). The economics of human capital and education: Implications for GDP growth. *Journal of Economic Perspectives*, 34(3), 97-122.
[14] Killian, L., & Lewis, L. (2011). The effect of real interest rate shocks on crude oil prices. *Review of Economics and Statistics*, 93(4), 1024-1041.
[15] Kostantinos, T., & Papadopoulos, D. (2022). Geopolitical factors affecting crude oil prices. *Energy Economics Journal*, 31(1), 45-63.
[16] Li, Q., & Zhang, Y. (2021). Exchange rates and trade balances: Evidence from emerging markets. *Economic Modelling*, 16(2), 123-145.
[17] Lopez-Villavicencio, A. (2019). Crude oil and core inflation: A time-series approach. *Journal of Applied Economics*, 21(2), 141-157.
[18] Kim, Myung Suk. "Impacts of supply and demand factors on declining oil prices." *Energy* 155 (2018): 1059-1065. https://doi.org/10.1016/j.energy.2018.05.061
[19] Sek, S. K. (2023). Economic recovery and crude oil prices during COVID-19. *Journal of Energy Economics*, 40(1), 12-25.
[20] Zhang, X., Liu, W., & Huang, R. (2018). Wavelet transforms and ARIMA in oil price forecasting. *International Journal of Forecasting*, 34(2), 456-471.
[21] Zhang, Y., Wang, L., & Chen, Z. (2021). ARIMA and artificial neural networks for GDP forecasting. *Journal of Economic Modeling*, 30(1), 90-103.
[22] Carvalho, Carlos, Andrea Ferrero, and Fernanda Nechio. "Demographics and real interest rates: Inspecting the mechanism." *European Economic Review* 88 (2016): 208-226. https://doi.org/10.1016/j.euroecorev.2016.04.002
[23] Teh, K., & Ling, H. S. (2015). *Malaysian ringgit at multi-year low: What is the current state of the economy?* Kuala Lumpur: Bond Pricing Agency Malaysia.